Galvanometer Scanning Technology for Laser Additive Manufacturing

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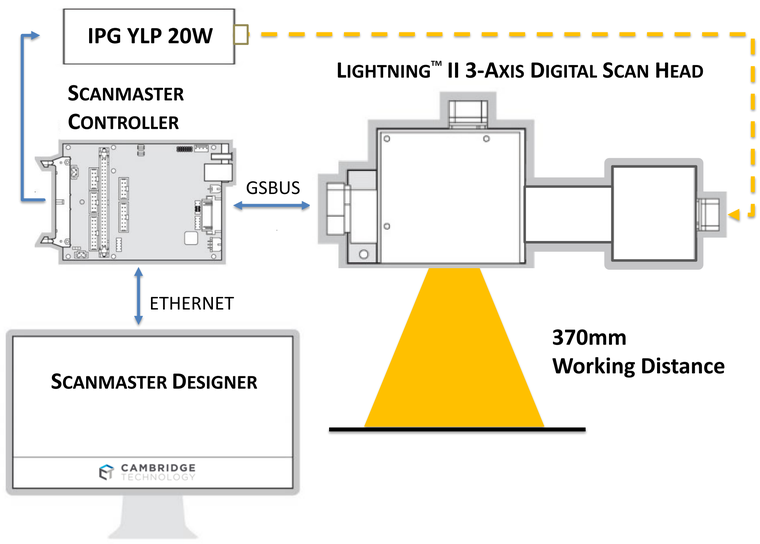
INTRODUCTION

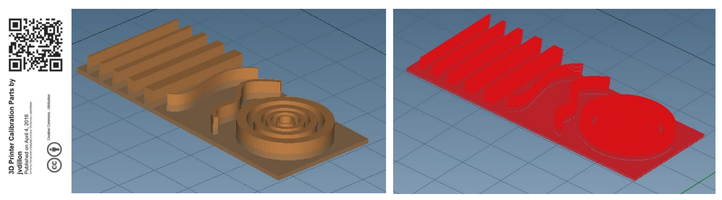
A galvanometer-based laser scanning system is an essential element in many laser additive manufacturing technologies. Fast, accurate laser scanning with smart controls to synchronize the laser and scanning system can effectively improve build part quality and job throughput. This results in a reduction in the cost of each manufactured part, enabling many industries to take advantage of additive manufacturing.

EXPERIMENTS

Experiment Set Up



Job Example: Thin wall structure

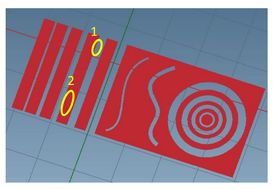


3D model (STL file) incorporated

3D model sliced and hatched

Objectives:

1: Uniform Laser Density



Method:

- Extract a single layer from the 3D model.
- Use both ScanPack control and Velocity Based Laser Modulation technique to mark the outline and hatch solid areas.

2: Throughput Improvement

Method:

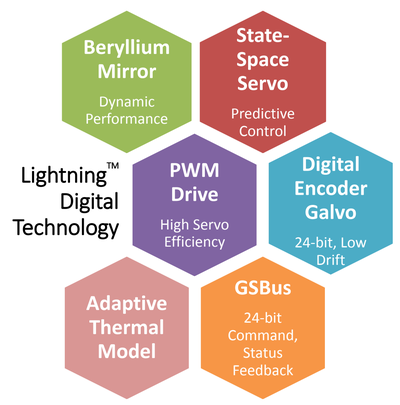
- Mark all layers of the 3D model using both conventional and ScanPack control.
- Compare the time required to complete the entire job (job throughput).

TECHNOLOGY

Digital Scanning Technology

Optimized Galvanometer, Servo Driver, Mirror, Control and Communication in a single, integrated platform.

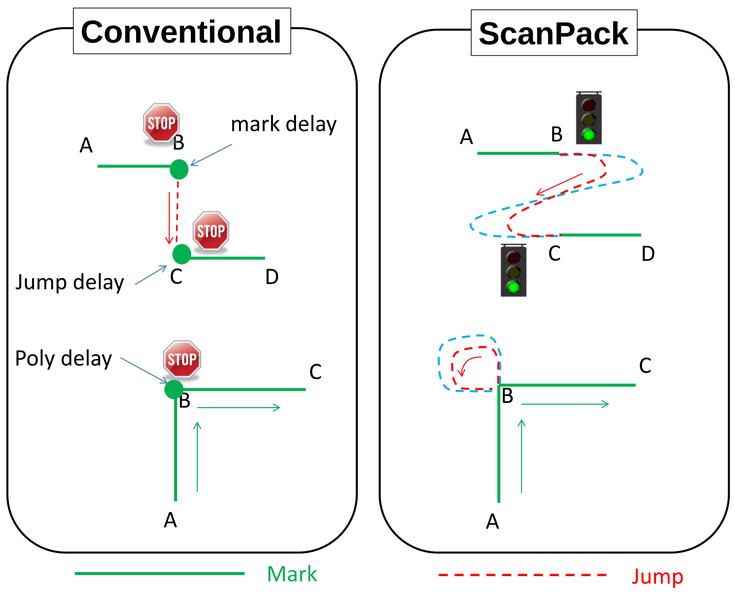
- 50 rad-optical/s (30mm scan head)
- 24-bit command resolution (e.g.17nm in 400mm field versus 4.5µm for 16-bit)
- < 10 µm patterning accuracy in 400x400mm field
- Low long term drift and thermal stability for stable, 24/7 performance



Smart Control Techniques For Uniform Laser Density

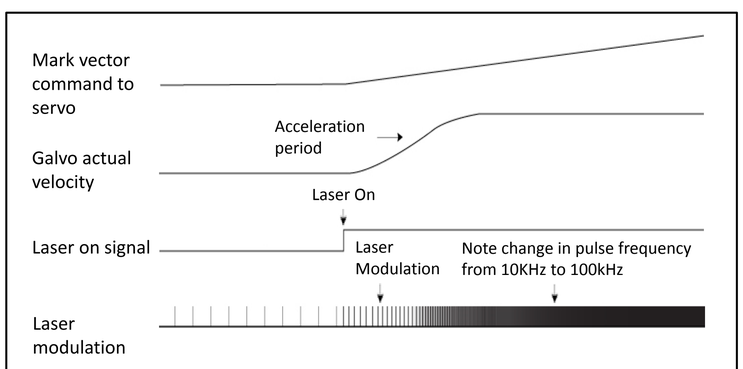
I. ScanPack Maintains Constant Velocity

- Accuracy-oriented trajectory planning
- True skywriting: automatic optimization based on local geometry
- End Velocity Control



II. Velocity Based Laser Modulation

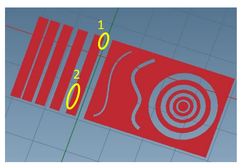
- Modulate laser frequency, power or pulse width based on scanner speed variation to maintain constant energy deposition on material.

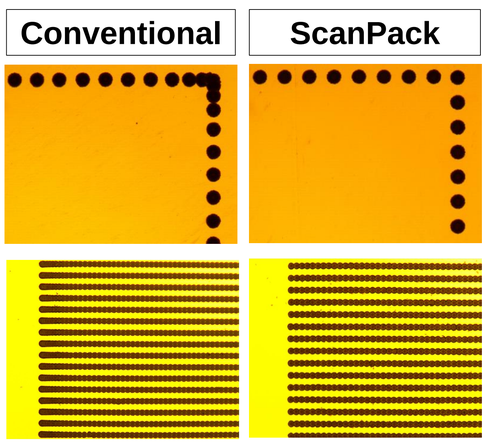


Example: Velocity-based Laser Modulation of Frequency

RESULTS

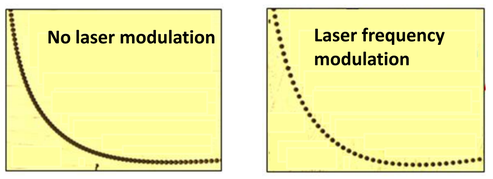
I. Uniform Laser Density with ScanPack Constant Velocity





II. Uniform Laser Density with Velocity Based Laser Modulation

Outcome of corner marking using conventional control with and without laser modulation of frequency



III. 23% Improvement in Job Throughput with ScanPack Control

Thin Wall Structure Job Parameters

Conventional		ScanPack	
Mark Speed	2700 mm/s	Mark Speed	2700 mm/s
Jump Speed	2700 mm/s	Jump Speed	N/A
Mark Delay	300 µs	Mark Delay	N/A
Jump Delay	150 µs	Jump Delay	N/A
Poly Delay	75 µs	Poly Delay	N/A
Job Throughput	**37.4 s**	**Job Throughput**	**30.4 s**

CONCLUSION

We present digital scanning technology to meet the ***accuracy, speed*** and ***stability*** requirements for additive manufacturing. We also demonstrate two control techniques to deliver ***uniform laser density*** on the material, which greatly improves the quality of the manufactured part. Additionally, ScanPack control can ***improve job throughput*** by 20-30% over conventional control.

REFERENCES

1. "3D Printer Calibration Parts" by jvdillon, licensed under the Creative Commons - Attribution license, <http://www.thingiverse.com/thing:1463326> (4 April 2016).